

(12) UK Patent Application (19) GB (11) 2 382 142 (13) A

(43) Date of A Publication 21.05.2003

(21) Application No 0127580.9

(22) Date of Filing 16.11.2001

(71) Applicant(s)
NSK European Technology Co Limited
(Incorporated in the United Kingdom)
Mere Way,
Ruddington Fields Business Park,
Ruddington, NOTTINGHAM, NG11 6JZ,
United Kingdom

(72) Inventor(s)
Carlo Roberto Bianco
Ian Taylor Cook
Anthony Francois Patrick Gauthier

(74) Agent and/or Address for Service
Brookes Batchellor
102-108 Clerkenwell Road, LONDON,
EC1M 5SA, United Kingdom

(51) INT CL⁷
G01P 3/44

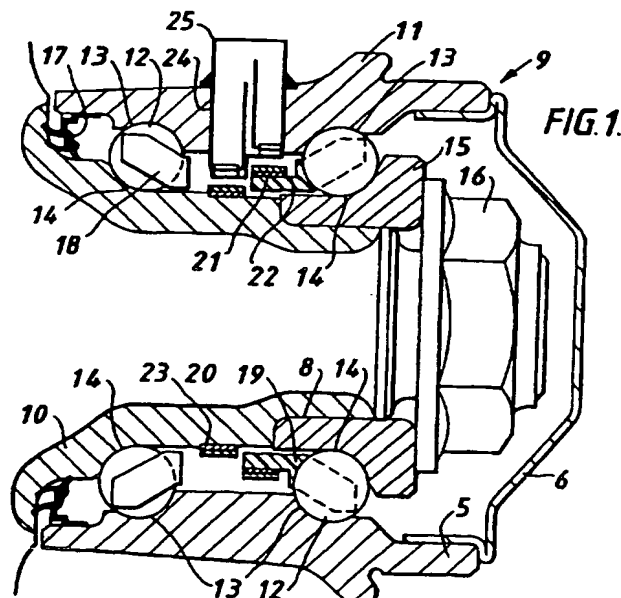
(52) UK CL (Edition V)
G1N NAGD1
U1S S1844 S2149

(56) Documents Cited
GB 1353306 A **EP 0887647 A1**
DE 002941564 A1 **FR 002558223 A**
JP 630176761 A **US 5046867 A**
US 5026178 A

(58) Field of Search
UK CL (Edition T) **G1N NAGB1 NAGC1 NAGD1**
INT CL⁷ **B60T 8/00 8/32, G01P 3/44 3/487 3/488**
Other: Online: **EPODOC, WPI, PAJ**

(54) Abstract Title
Wheel bearing assemblies incorporating sensing arrangements

(57) A vehicular wheel bearing assembly with relatively rotatable bearing rings (11, 10) and rolling elements (12) therebetween incorporates a sensing arrangement for sensing speed or position. The sensing arrangement is composed of pre-formed annular encoders (21, 23) with alternate magnetic north and south poles which are offset both radially and axially relative to the rotational axis defined by the bearing rings (10, 11). The encoders (21, 23) are mounted on different components of the assembly, for example on a cage (19) and one of the bearing rings (10) which is intended to rotate. Sensors (28, 29) in a housing (25) fitted to the outer bearing ring (11) intended to remain stationary detect the movement of the poles of the respective encoders (21, 23) to generate electrical signals which can be combined or processed separately. In an alternative embodiment, only one encoder mounted on the cage is used, with a sensor on another part of the assembly.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

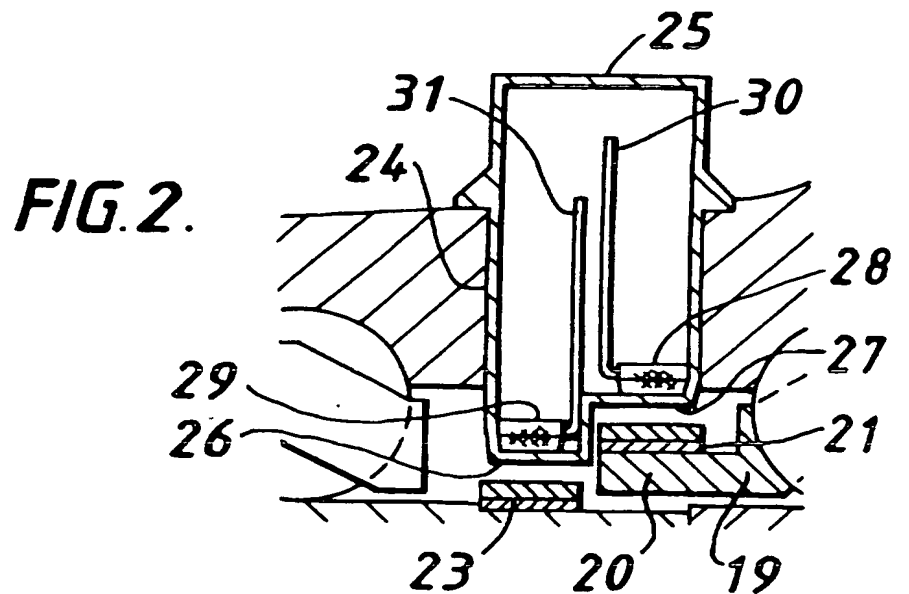
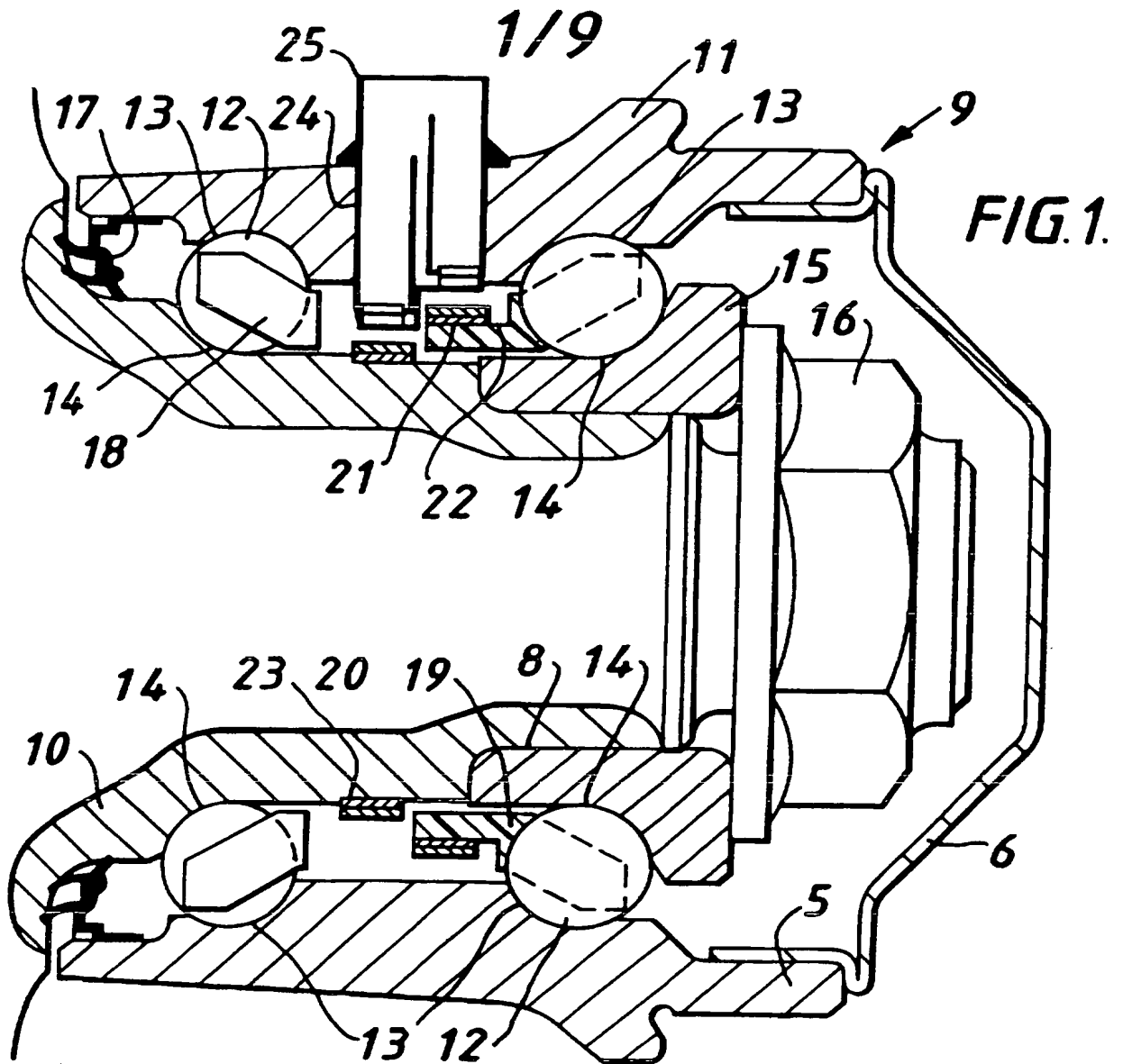


FIG. 3.

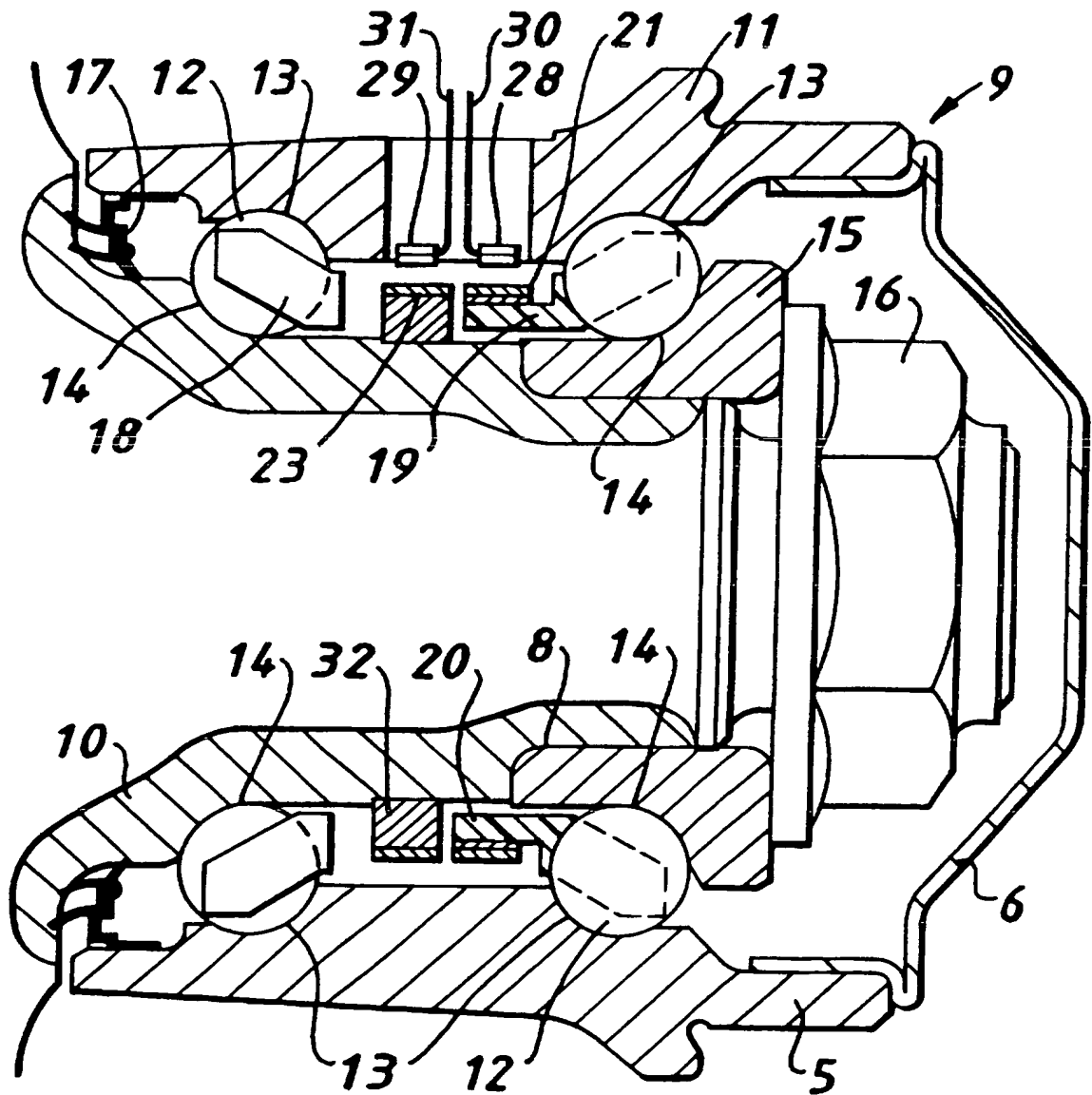
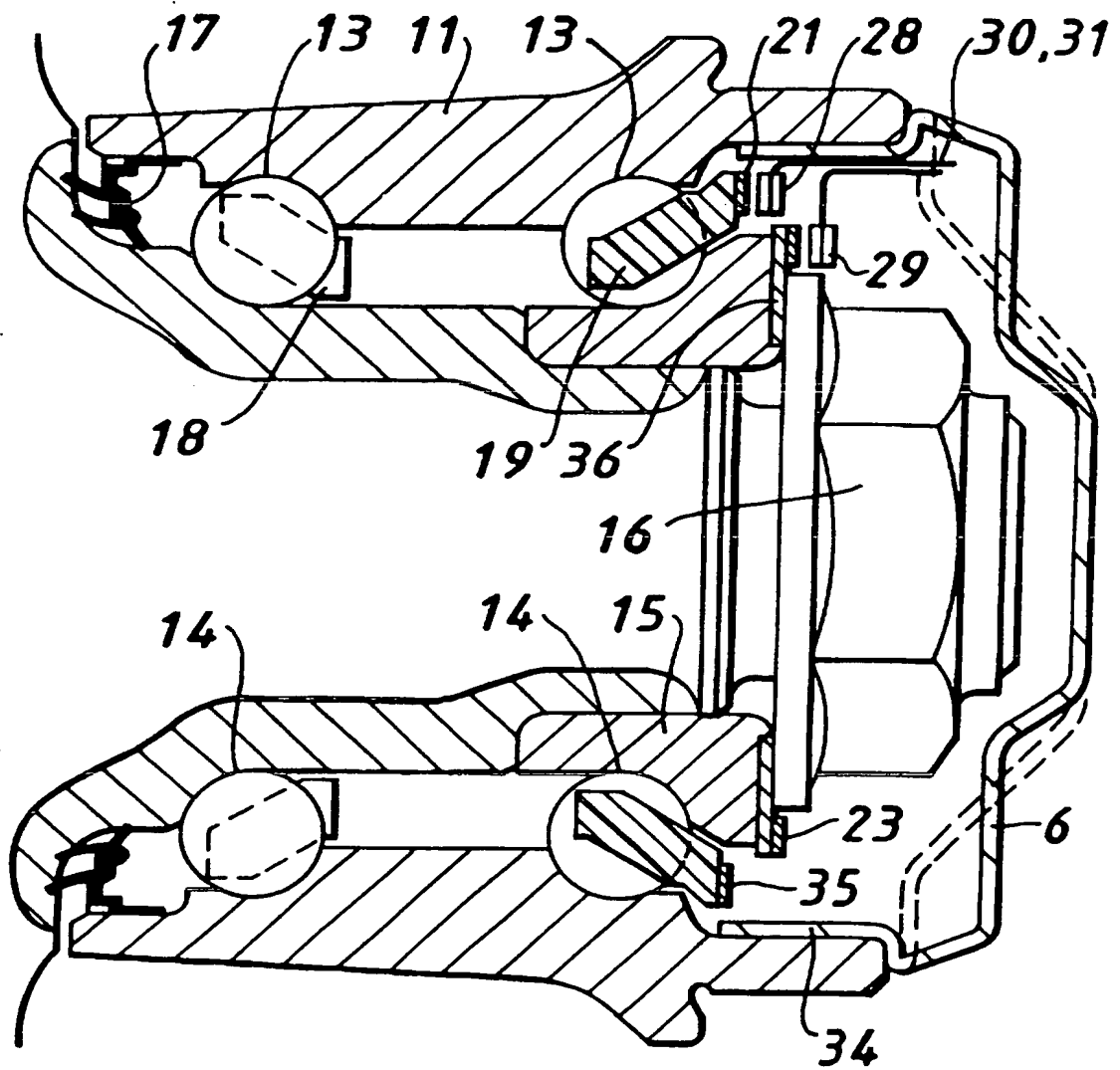




FIG. 5.



5/9

FIG. 6.

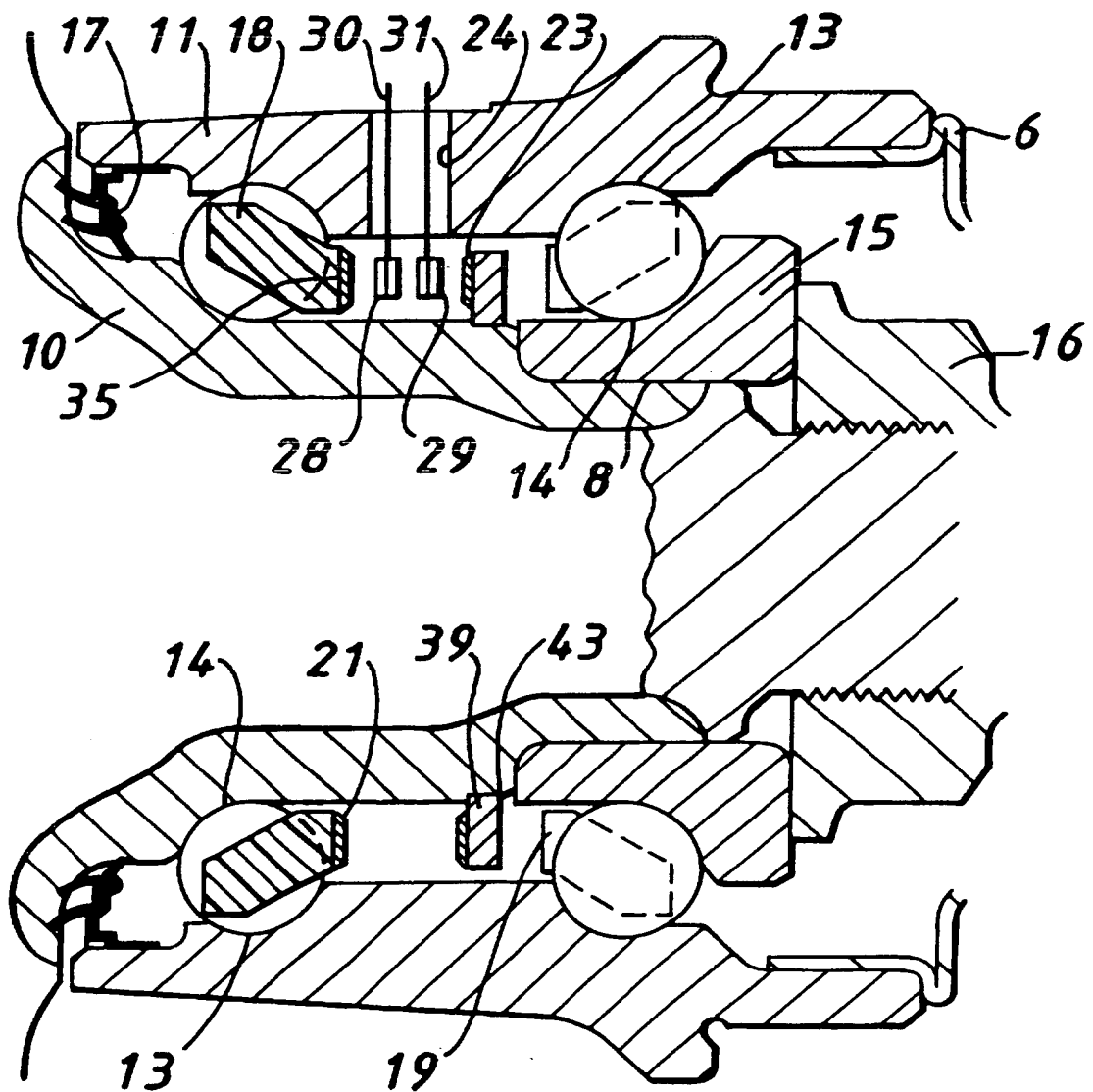
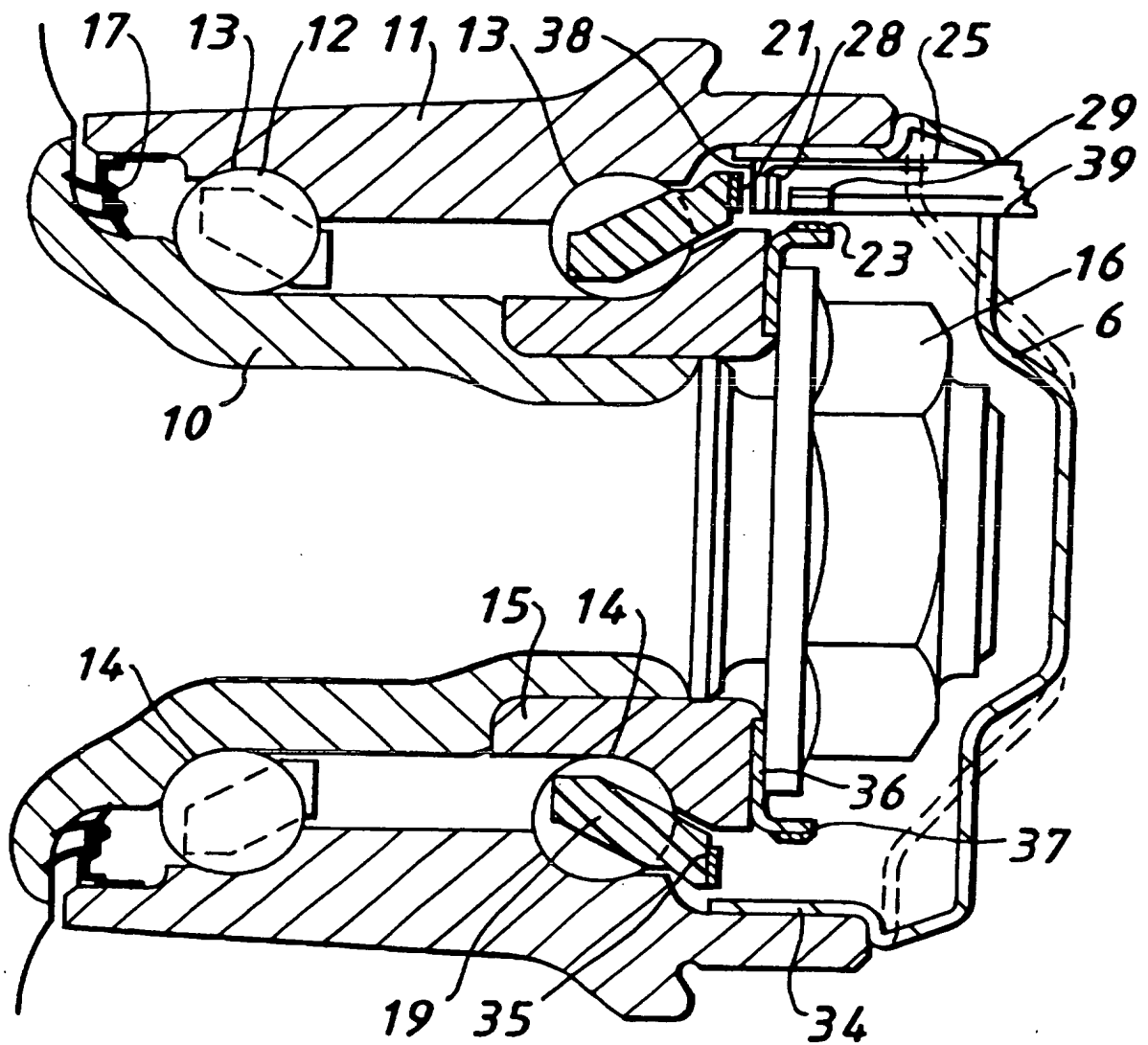
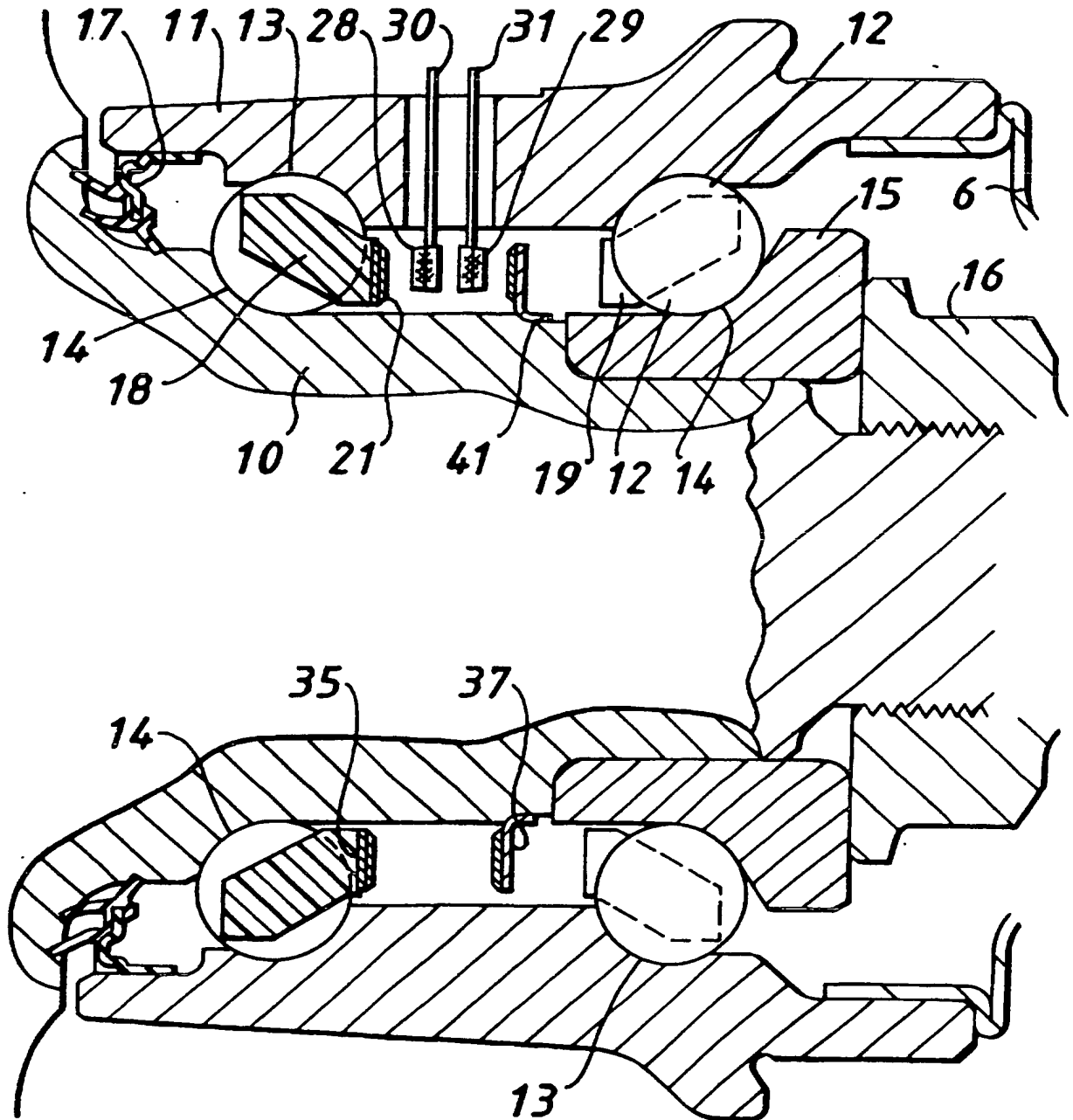


FIG. 7.



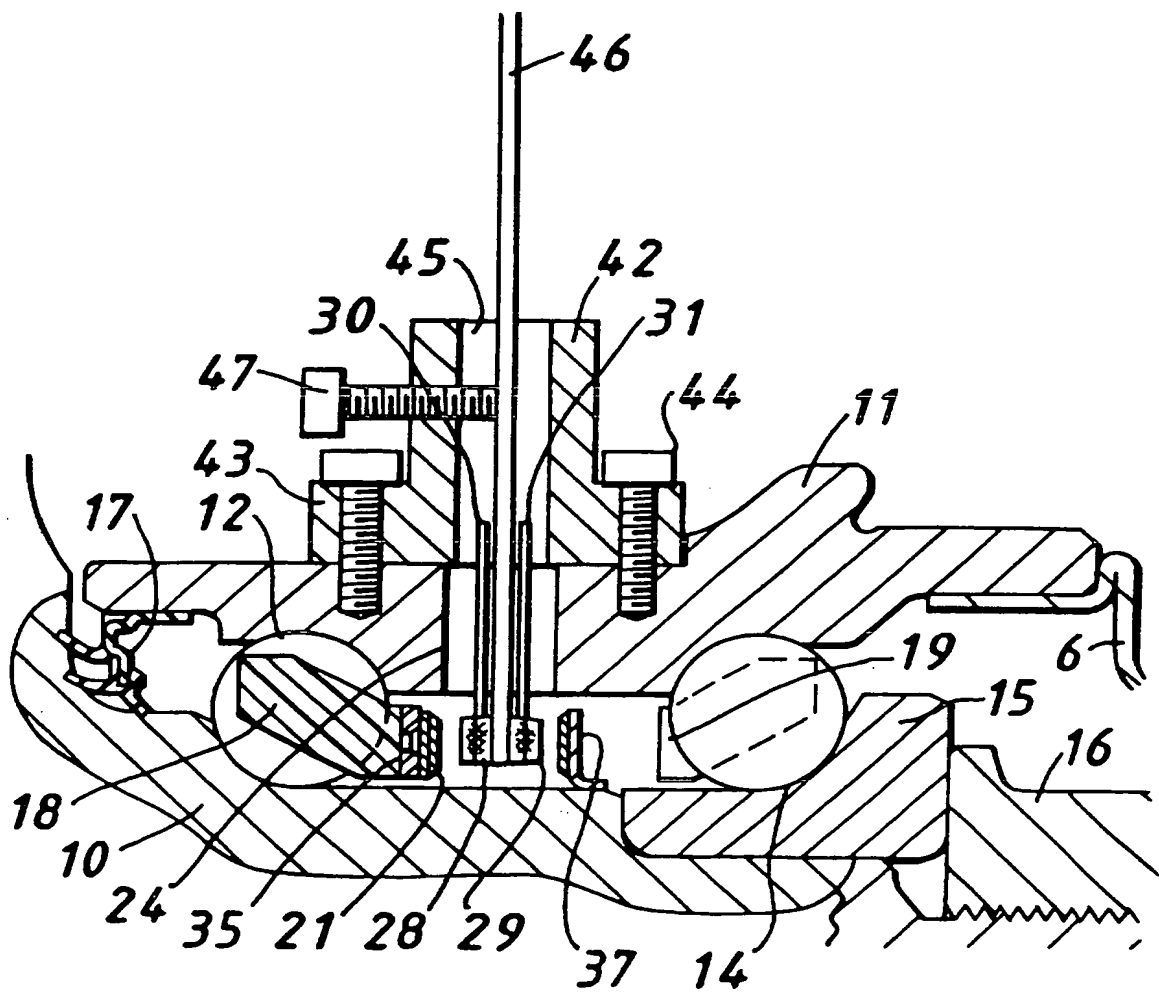
7/9

FIG. 8.



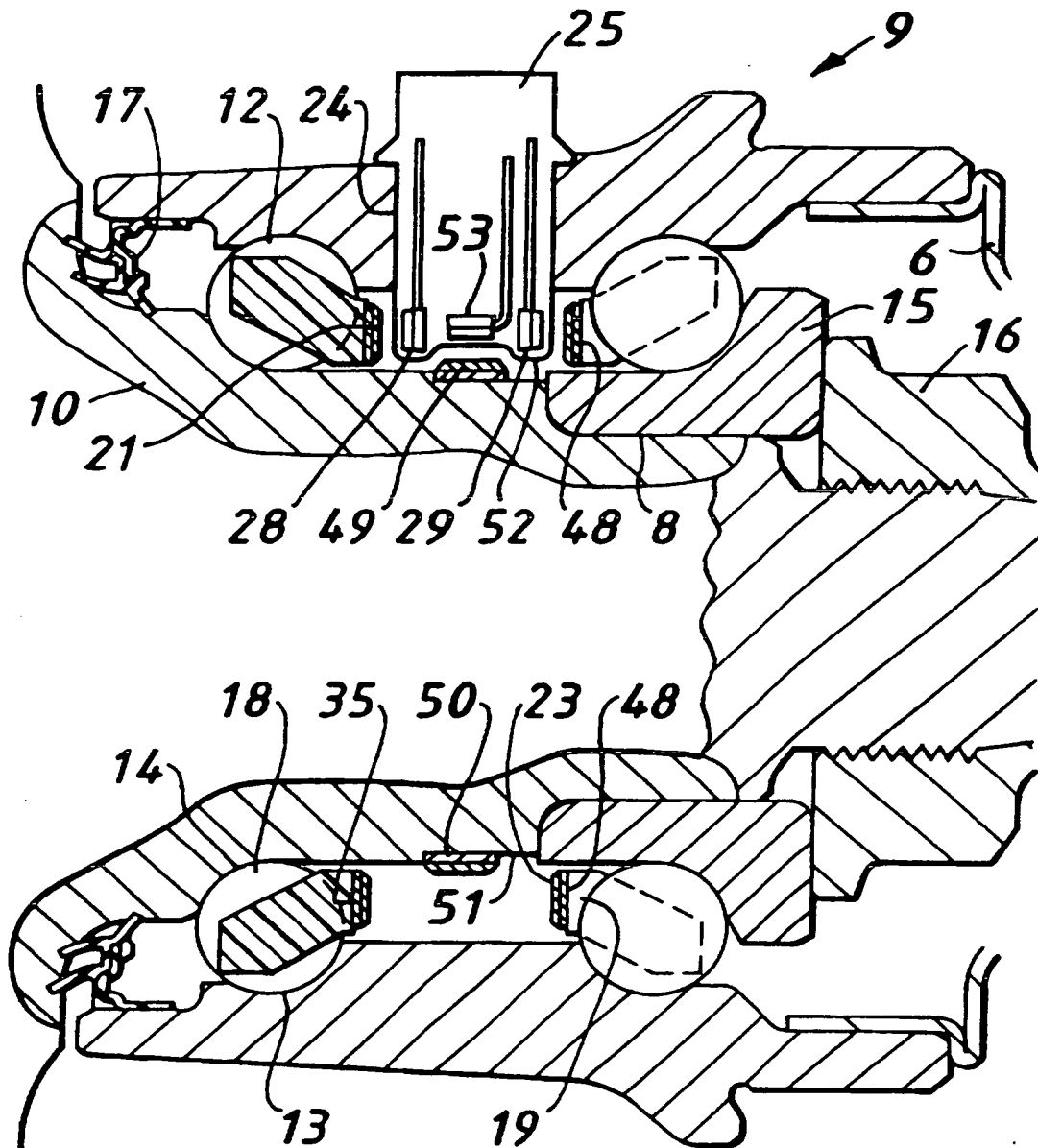
8/9

FIG. 9.



9/9

FIG. 10.



Wheel Bearing Assemblies Incorporating Sensing Arrangements

The present invention relates to vehicle wheel bearing assemblies and more particularly to such assemblies equipped with sensing arrangements for sensing rotary speed or position.

In this field there have been many prior art constructions which can be taken to form the background for the invention. In general, rotary bearings employing sensing arrangements for sensing rotary speed or position can employ a pre-fabricated annular component made of polymeric material containing ferrous material which is treated to form alternate north and south magnetic poles, see for example, US Patent 5089817. Such a component referred to as an encoder can be mounted in the assembly to cause the magnetic poles to pass alongside a sensor, such as a Hall effect sensor, which generates a pulsed electrical signal.

An object of the present invention is to provide improved assemblies and sensing arrangements of the aforementioned kind.

According to one aspect of the present invention there is provided a wheel bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of at least two annular encoders with alternate north and south

magnetic poles and at least two sensors operably associated with the encoder and each serving to provide electrical signals generated by the passage of the poles of the associated encoder.

The encoder can be mounted on different components of the assembly such as on one of the cages and on the rotatable bearing ring. This enables the signals generated by the sensors to be compared, for example. The encoders can be orientated with their magnetic poles parallel to the rotational axis thus in an axial orientation or radial to this axis thus in a radial orientation or in both axial and radial orientations. The sensors and encoders may be built into the bearing in a protected position between the sets of rolling elements. To locate the sensors use can be made of a housing or a mounting as described hereinafter.

In other embodiments the sensors and encoders lie outboard of the bearing and the wheel assembly for ease of installation or removal.

In another aspect of the present invention there is provided a bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the encoder;

wherein the encoder is mounted on the cage of one of the sets of rolling elements and the sensor is mounted on the stationary bearing ring.

In a further aspect of the present invention there is provided a bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, at least one set of rolling elements between the rings and in contact with tracks defined by the rings with the rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the associated encoder;

wherein the encoder is mounted on the cage and the sensor is mounted on another component of the assembly.

In another aspect of the present invention there is provided a wheel bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the encoder;

wherein the encoder is mounted in face-to-face contact with one of the cages in a predominantly radial or axial disposition and the sensor is mounted on another component of the assembly.

The invention may be understood more readily, and various other aspects and features of the invention may become apparent, from consideration of the following description.

Embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings, wherein:

Figure 1 is a schematic sectional side view of a wheel bearing assembly constructed in accordance with the invention;

Figure 2 is a view of part of the assembly shown in Figure 1 and taken on a larger scale;

Figures 3 to 7 are views corresponding to Figure 1 and representing other wheel bearing assemblies constructed in accordance with the invention;

Figure 8 is a view of the assembly shown in Figure 6 and taken on a larger scale to illustrate a modified construction;

Figure 9 is a schematic sectional side view of part of a further wheel bearing assembly constructed in accordance with the invention and

Figure 10 is a schematic sectional side view of another wheel bearing assembly constructed in accordance with the invention.

The construction of the various wheel bearing assemblies 9 illustrated throughout the accompanying drawings is well known *per se* and like reference numerals are used to designate the same components.

Referring initially to Figure 1, there is an inner bearing ring 10, an outer bearing ring 11 and two sets or rows of rolling elements in the form of balls 12 therebetween. The balls 12 make angular contact with running tracks 13, 14 in the rings 10, 11. In this assembly, the right-hand or innermost track 14 of the ring 10 is actually formed by a separate support 15 located in a recess 8 in the inner ring 10. A wheel hub is fixed to or integral with the inner ring 10 and receives a nut 16 which locates on the support 15. A detachable pressing fits into an outer projecting region 5 of the outer ring 11 and acts as a cover 6 for the nut 16. At the opposite left-hand or outermost end regions of the rings 10, 11 there is a seal 17. Each set of balls 12 is fitted into a cage 18, 19 made of plastics material. As is known, the cages 18, 19 maintain separation between the balls 12 and guide the balls 12 making up each set for progression around the tracks 13, 14. During use, the inner ring 10 rotates with the wheel hub whilst the outer ring 11 remains stationary. The balls 12 progressively roll in relation to the tracks 13, 14.

In accordance with the invention, the assembly 9 is equipped with a sensing arrangement designed to provide an indication of rotary speed or position. As shown in Figures 1 and 2, the

cage 19 has an axial projection 20 which extends outwardly towards the other ball set. A first pre-formed annular encoder 21 with alternate axially-orientated north and south magnetic poles is fitted onto an axial surface 22 of the projection 20 to confront the inner surface of the outer ring 11. A second pre-formed annular encoder 23 with alternate north and south axially-orientated magnetic poles is fitted onto the inner surface of the inner bearing ring 10. The encoders 21, 23 are axially and radially offset in relation to one another.

A radial bore 24 in the outer ring 11 receives a housing 25. As shown in Figure 2, the inner end of the housing 25 has a stepped profile with end walls 26, 27 offset in the radial direction. The end walls 26, 27 mount sensors 28, 29 which detect the passage of the magnetic poles of the encoders 21, 23 and provide pulsed electrical signals with a repetition frequency depending on the movement of the poles of the encoders 21, 23. The signals are carried on leads 30, 31 connected with the sensors 28, 29. The signals from the sensor 28 represent the rotary speed of the cage 19 while the signals from the sensor 29 represent the rotary speed of the inner ring 10. The signals can be used in a variety of ways quite separately and independently or combined or compared with one another.

Figure 3 shows a modified form of the sensing arrangement shown in Figures 1 and 2. In this arrangement, the encoder 23 is mounted on a support ring 32 fitted to the inner surface of the inner bearing ring 10 and the magnetic poles of the encoders 22, 23 lie in a common axial plane. The associated sensors 28, 29 are likewise orientated in a common axial plane corresponding to the inner surface of the outer ring 11. The sensors 28, 29 are mounted at the inner end of a bore

24 in the ring 11. The leads 30, 31 are used to support and position the sensors 28, 29 and these leads 30, 31 emerge from the bore 24.

In the embodiments described and illustrated so far the encoders and sensors 21, 23, 28, 29 are all inboard between the sets of balls 12.

In other constructions the encoders and sensors can be outside the bearing interior. Thus, Figure 4 shows another sensing arrangement with two encoders 21, 23 and two sensors 28, 29. The first encoder 21 is again located on an axial projection 20 of the cage 19 but in this embodiment the projection 20 extends outwardly rather than inwardly. The second encoder 23 is mounted on an axial region of a further L-shaped ring 33 disposed outside the bearing. A radial region of this ring 33 is clamped by the nut 16 against the support 15. As with the arrangement shown in Figure 3, the magnetic poles of the encoders 21, 23 lie in a common axial plane as do the opposed associated sensors 28, 29 which are now supported on an axial portion 34 of the cover 6.

In the assemblies and arrangements depicted in Figures 1 to 4 the encoders 21, 23 and the sensors 28, 29 are located predominantly in the axial disposition. Figures 5 and 6 show somewhat different arrangements where the encoders 21, 23 and the sensors 28, 29 take a radial disposition. In the arrangement shown in Figure 5 the encoder 21 is mounted on an outermost radial surface 35 of the outer cage 19 so the magnetic poles take a radial orientation. The encoder 23 is here mounted on a plane washer 36 clamped between the nut 16 and the support 15. As can be seen, the encoders 21, 23 are both axially and radially offset. The associated sensors 28, 29 are likewise axially and radially offset and suspended, for example, by a deformable sleeving

surrounding the leads 30, 31 and bent into an L-shape. The sleeving can be secured to the axial portion 34 of the cover 6 in any suitable fashion.

Figure 6 shows another arrangement with the encoders 21, 23 and the sensors 28, 29 all in a radial orientation. In this arrangement, the encoder 21 is supported on the innermost radial end face 35 of the cage 18. The encoder 23 confronts the encoder 21 and is radially aligned but axially offset with respect to the encoder 21. A support ring 39 fits into a recess 43 in the inner surface of the inner bearing ring 10 and the support ring 39 serves to mount the encoder 23. The associated sensors 28, 29 are again suspended by their leads 30, 31 in the sensor vicinity of the encoders 21, 23. The leads 30, 31 pass through the bore 24 in the bearing ring 11.

Figure 7 shows an arrangement where the encoders 21, 23 and the sensors 28, 29 are orientated both radially and axially. Thus, the encoder 21 is again mounted on the radial surface 35 of the cage 18 as is in the embodiment shown in Figure 5. However the washer 36 is now L-shaped with an axial region 37 supporting the encoder 23 in an axial orientation generally normal to the orientation of the encoder 21. A tubular housing 25 again secured to the axial portion 34 of the cover 6 accommodates the sensors 28, 29. The housing 25 has a radially orientated inner end wall 38 supporting the sensor 28 in the sensing vicinity of the encoder 21 and an axial wall 39 supporting the sensor 29 in the sensing vicinity of the encoder 23.

Figure 8 depicts a similar arrangement to Figure 6 but here the shape and mass of the support ring 37 for the encoder 21 is modified. The ring 39 is now L-shaped and has an axial flange portion

41 fitted directly to the inner surface of the inner ring 10 which is no longer provided with a recess.

Figure 9 is again similar to the arrangement shown in Figure 8 but here the encoder 21 is fixed to the cage 18 with screws. In this arrangement the mounting of the sensors 28, 29 is achieved with the aid of a mounting block 42. The mounting block 42 has a flange 43 affixed with screws 44 to the outer bearing ring 11. A bore 45 in the block 42 is co-axial with the bore 24 in the ring 11. An elongate carrier 46 extends through the bores 45, 24 and mounts the sensors 28, 29 face-to-face in opposite directions. A further screw 47 is received in a wall of the block 42 to penetrate the bore 45 and the screw can be used to adjustably locate with the carrier 46.

In the assemblies and arrangements depicted in the drawings and described hereinbefore there is two encoders and two sensors. In Figure 10 a modified arrangement is depicted which uses three encoders and three sensors. Thus in Figure 10 a first encoder 21 is mounted on an outer end surface 35 of the cage 18 and takes a radial orientation. A second encoder 23 is mounted on the inwardly directed end face 48 of the cage 19 in confronting relationship to the encoder 21 and likewise take a radial orientation. The encoders 21, 23 are in radial alignment but spaced apart axially. A third encoder 49 is mounted on a support ring 50 fitted in a shallow recess 51 in the inner surface of the inner ring 10. The third encoder 49 takes an axial orientation. The sensors associated with the encoders are again supported by a common housing 25 located in their bore 24 in the outer bearing ring 11. In this case the radially orientated sensors 28, 29 associated with the encoders 21, 23 are located in an annular ridge portion 52 at the end of the housing 25 while a further sensor 53 associated with the third encoder 49 and located in an axial orientation is

located centrally of the inner end of the housing 25 within the end ridge portion 52 and radially offset therefrom.

CLAIMS

1. A wheel bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of at least two annular encoders with alternate north and south magnetic poles and at least two sensors operably associated with the encoders and each serving to provide electrical signals generated by the passage of the poles of the associated encoder;

wherein the encoders are mounted on different components of the assembly and the sensors are both mounted on the same component.

2. An assembly according to claim 1, wherein the magnetic poles of the encoders are orientated parallel to the rotational axis.

3. An assembly according to claim 1, wherein the magnetic poles of the encoder are orientated radially relative to the rotational axis.

4. An assembly according to claim 1, wherein the magnetic poles of at least one of the encoders are orientated radially relative to the rotational axis and the magnetic poles of at least one other of the encoders are orientated parallel to the rotational axis.

5. An assembly according to claim 1, 2, 3 or 4, wherein the sensors and the encoders are disposed between the sets of rolling elements.
6. An assembly according to claim 1, 2, 3 or 4, wherein the sensors and encoders are disposed outwardly beyond one of the sets of rolling elements and remote from the other set of rolling elements.
7. An assembly according to any one of the preceding claims, wherein the encoders are spaced apart both in a radial and an axial sense.
8. An assembly according to any one of the claims 1 to 6, wherein the encoders are spaced apart axially but aligned radially in relation to the rotational axis.
9. An assembly according to any one of the preceding claims, wherein one of the encoders is mounted on the cage for one of the sets of rolling elements and the other of the encoders is mounted on said one rotatable bearing ring or on a component which rotates with said one ring.
10. An assembly according to any one of the preceding claims, wherein the sensors are mounted in a housing fitted into a bore in the other stationary bearing ring so the housing locates the sensor in sensing vicinity to the associated encoders.
11. An assembly according to any one of claims 1 to 9, wherein the sensors are mounted in a bore in the other stationary bearing ring.

12. An assembly according to claim 1, 2 or 3 or claim 6, 8 or 9 when dependent only on claims 1, 2 or 3, wherein the inner bearing ring is clamped with a nut onto a wheel hub, a cover is located on the other bearing ring to enclose the nut and the sensors are carried by an axial portion of the cover.

13. An assembly according to any one of claims 1, 3, 5, 8 or 9, wherein the sensors are mounted on an elongate carrier adjustably supported in a mounting fitted to the other bearing ring.

14. A bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the encoder;

wherein the encoder is mounted on the cage of one of the sets of rolling elements and the sensor is mounted on the stationary bearing ring.

15. A bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, at least one set of rolling elements between the rings and in contact with tracks defined by the rings with the rolling

elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the associated encoder;

wherein the encoder is mounted on the cage and the sensor is mounted on another component of the assembly.

16. A wheel bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the encoder;

wherein the encoder is mounted in face-to-face contact with one of the cages in a predominantly radial or axial disposition and the sensor is mounted on another component of the assembly.

17. A wheel bearing assembly composed of inner and outer bearing rings, one of which is intended to rotate and the other of which is intended to remain stationary, sets of rolling elements between the rings and in angular contact with tracks defined by the rings, the sets of rolling elements being spaced apart in the direction of the axis of rotation with each set of rolling elements being retained by a cage and a sensing arrangement composed of an annular encoder

with alternate north and south magnetic poles and a sensor operably associated with the encoder and serving to provide electrical signals generated by the passage of the poles of the associated encoder;

wherein the encoder is mounted on one of the cages in a position between the sets of rolling elements and the sensor is mounted on another component of the assembly.

18. A wheel bearing assembly incorporating a sensing arrangement and substantially as described with reference to, and as illustrated in any one or more of the Figures of the accompanying drawings.



INVESTOR IN PEOPLE

Application No: GB 0127580.9
Claims searched: 1 to 13

Examiner: Ian Rees
Date of search: 1 July 2002

Patents Act 1977 : Amended Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 at least	FR 2558223 PEILLOUD. See figure 9 and page 5 (line 12) to page 6 (line 5).
A		EP 0887647 A1 NSK. See figures 1 to 8.
A		US 5046867 TORRINGTON. See figures.
A		JP 63-176761 KOYO SEIKO. See figures and PAJ abstract.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^v:

G1N

Worldwide search of patent documents classified in the following areas of the IPC⁷ :

B60T; G01P

The following online and other databases have been used in the preparation of this search report :

EPODOC, WPI, PAJ



INVESTOR IN PEOPLE

Application No: GB 0127580.9
Claims searched: 14 to 17

Examiner: Ian Rees
Date of search: 26 February 2003

Patents Act 1977 : Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	14 to 17	US 5026178	BALLHAUS. See figures and column 2 (line 52) to column 3 (line 19).
X	14 to 17	GB 1353306	SKF. See page 2 (lines 29 to 107).
X	14 to 17	DE 2941564 A1	SCHULZ. See figures and WPI abstract accession no 1981-D9150D[18].
X	14 to 17	FR 2558223	PEILLOUD. See figures 8 and 9, page 3 (lines 29 to 34) and page 5 (line 12) to page 6 (line 5).
X	14 to 17	JP 63-176761	KOYO SEIKO. See figures and PAJ abstract.

Categories:

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
Y Document indicating lack of inventive step if combined with one or more other documents of same category.	P Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^v:

G1N

Worldwide search of patent documents classified in the following areas of the IPC⁷:

B60T; G01P

The following online and other databases have been used in the preparation of this search report :

EPODOC, WPI, PAJ